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09/538,053      29 March 2000 (29.03.2000)      **US**
- (71) Applicant (for all designated States except US): **POWER-WARE CORPORATION** [US/US]: 8609 Six Forks Road, Raleigh, NC 27615 (US).
- (72) Inventors; and
- (73) Inventors/Applicants (for US only): **LAYDEN, David**

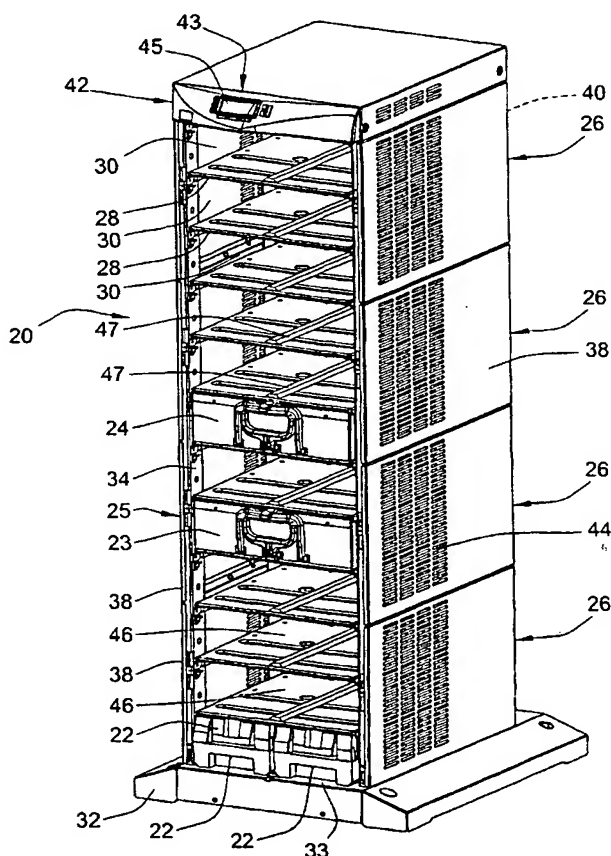
[US/US]: N7692 11th Avenue South, New Lisbon, WI 53950 (US). **EDEVOLD, Craig** [US/US]: 523 Clark Street, Tomah, WI 54660 (US). **WINCH, Cary** [US/US]: 503 Peach Street, Necedah, WI 54646 (US). **ZAHRT, Donald, Sr.** [US/US]: N10045 18th Avenue, Necedah, WI 54646 (US).

(74) Agent: **MAKEEVER, Jeffery**; Leydig, Voit & Mayer, Ltd., 6815 Weaver Road, Suite 300, Rockford, IL 61114-8018 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: **SYSTEM FOR DETECTING DEFECTIVE BATTERY PACKS**



(57) Abstract: An electrical cabinet for an uninterruptible power supply (UPS) system includes universal slots that can receive power modules, battery packs, or chargers. The back plane of the slot has connector terminals for battery packs and power modules. The cabinet can be easily reconfigured as desired by changing the number of power modules, chargers or battery packs installed. Circuitry is provided that indicates the capacity and operational readiness of the cabinet. This circuitry monitors the battery packs in each slot, and isolates any detected fault to a particular battery pack.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

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# INTERNATIONAL SEARCH REPORT

Internal Application No  
PCT/US 01/10083

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G01R31/36

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## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 020 743 A (SETO KAN-CHIU ET AL) 1 February 2000 (2000-02-01) abstract; figure 1	1-3
X	EP 0 977 047 A (NTT POWER AND BUILDING FACILIT) 2 February 2000 (2000-02-02) abstract; figure 1	1,22
A	column 2, line 57 -column 3, line 8 column 5, line 49 -column 5, line 57	15
A	US 4 316 185 A (WATROUS DONALD L ET AL) 16 February 1982 (1982-02-16) abstract	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

### \* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "&" document member of the same patent family

Date of the actual completion of the international search

21 December 2001

Date of mailing of the international search report

26.04.02

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.  
Fax: (+31-70) 340-3016

Authorized officer

Vytlačilová, L

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US 01/10083

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-27

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-27

A non-invasive method of monitoring operational readiness of electric power storage batteries, a method of detecting and identifying a failed battery pack, a system for detecting defective battery packs

2. Claims: 28 - 58

An electrical cabinet for configuring an uninterruptible power system, a back panel for use in an electrical cabinet, an uninterruptible power system

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/10083

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6020743 A	01-02-2000	NONE	
EP 0977047 A	02-02-2000	JP 2000048861 A	18-02-2000
		JP 2000048798 A	18-02-2000
		US 6014012 A	11-01-2000
US 4316185 A	16-02-1982	NONE	

PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>501197</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/US 01/ 10083</b>	International filing date (day/month/year) <b>29/03/2001</b>	(Earliest) Priority Date (day/month/year) <b>29/03/2000</b>
Applicant <b>POWERWARE CORPORATION</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☒ Unity of invention is lacking (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1  
☐ None of the figures.

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European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Vytlačilová, L



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because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
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1-27

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Information on patent family members

International Application No

PCT/US 01/10083

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 6020743	A	01-02-2000	NONE	
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EP 0977047	A	02-02-2000	JP 2000048861 A	18-02-2000
			JP 2000048798 A	18-02-2000
			US 6014012 A	11-01-2000
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US 4316185	A	16-02-1982	NONE	
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- Motozu, Tamotsu,  
c/o NTT Power and Building F. Inc  
Tokyo (JP)
- Tsujikawa, Tomonobu,  
c/o NTT Power and Building  
Tokyo (JP)
- Kawagoe, Yuji,  
c/o NTT Power and Building F. Inc.  
Tokyo (JP)

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(71) Applicant:  
NTT Power and Building Facilities Inc.  
Tokyo (JP)

(74) Representative:  
Schmidt-Evers, Jürgen, Dipl.-Ing. et al  
Patentanwälte Mitscherlich & Partner,  
Sonnenstrasse 33  
80331 München (DE)

(72) Inventors:  
• Murao, Tetsuro,  
c/o NTT Power and Building F. Inc.  
Tokyo (JP)

(54) Apparatus for managing a battery unit having storage batteries

(57) The voltages  $V$  of storage batteries ( $S_a$ ,  $S_b$ , ...  $S_n$ ) are detected, and the voltage  $E$  of the battery unit (10) is detected. A defect in each storage battery is detected in accordance with the voltage  $V$  detected. An abnormal voltage of the battery unit (10) is detected in accordance with the voltage  $E$  detected. Further, the

temperature  $T$  of the battery unit (10) is detected, on the basis of which the expiration of each storage battery is determined. The defect detected, the abnormal voltage detected, and the expiration determined are informed.

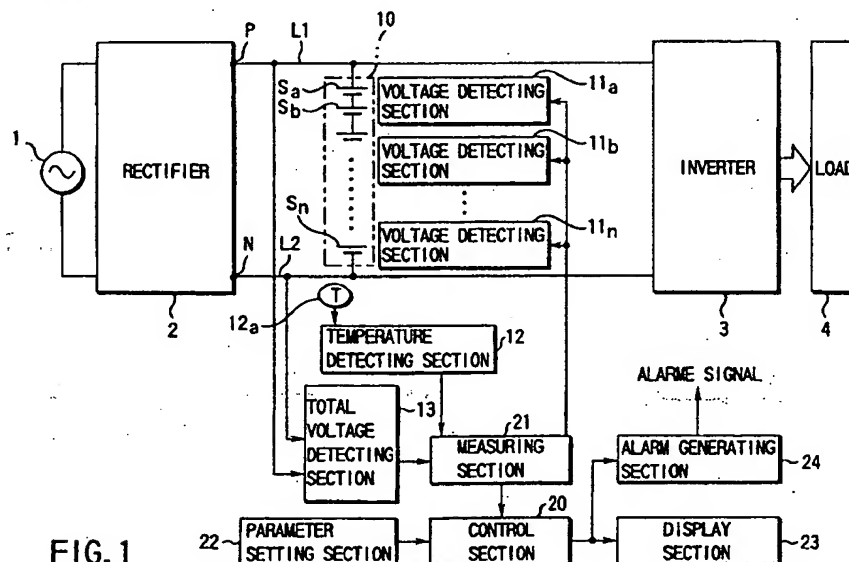


FIG.1

## Description

[0001] The present invention relates to an apparatus for managing a battery unit to be incorporated into, for example, an uninterruptible power supply system.

[0002] The uninterruptible power supply system comprises a battery unit. Power is supplied from the battery unit to a load when the commercial AC power supply fails to supply power, whereby the load can be driven without break. The battery unit comprises a plurality of storage batteries connected in parallel or in series.

[0003] In the uninterrupted power supply system it is necessary to inspect each storage battery periodically.

[0004] Recently, sealed-type lead storage batteries are used in great quantities as storage batteries. The jar of a sealed-type lead storage battery is sealed. This makes it impossible to determine whether the electrodes in the jar have been corroded or whether the electrolyte in the jar is insufficient in amount. It is therefore very difficult to detect whether each storage battery is defective (due to, for example, manufacturing errors) or has expired.

[0005] If any one of the storage batteries is defective or has expired, the battery unit may no longer supply power to the load.

[0006] The present invention has been made in view of the foregoing. Its object is to provide an apparatus for automatically managing, with high reliability, a battery unit having storage batteries, which can reliably detect and inform a defect in each storage battery and an abnormal voltage in the battery unit and reliably determine and inform the life of each storage battery, without requiring the service of inspection-maintenance workers.

[0007] An apparatus according to the present invention is designed to manage a battery unit having a plurality of storage batteries and comprises:

a plurality of first voltage detecting means for detecting voltages of the storage batteries, respectively;

second voltage detecting means for detecting a total voltage of the battery unit;

defect detecting means for detecting defects in the storage batteries on the basis of the voltages detected by the first voltage detecting means;

abnormality detecting means for detecting an abnormal voltage in the battery unit on the basis of the voltage detected by the second voltage detecting means;

temperature detecting means for detecting temperature in the battery unit;

battery life determining means for determining a life of each of the storage batteries has dead, on the basis of the temperature detected by the temperature detecting means; and

information means for informing results of the detection performed by the defect detecting means

and abnormality detecting means and results of the determination made by the battery life determining means.

[0008] This summary of the invention does not necessarily describe all necessary features so that the invention may also be a sub-combination of these described features.

[0009] The invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram showing an embodiment of this invention and an uninterruptible power supply system incorporating the embodiment;

FIG. 2 is a flow chart for explaining the operation of this embodiment;

FIG. 3 is a flow chart continuous to the flow chart shown in FIG. 2;

FIG. 4 is a chart for explaining how to determine the operation mode of the embodiment;

FIG. 5 is a chart for explaining how defects are detected in the embodiment operating in the float charge mode;

FIG. 6 is a chart for explaining how defects are detected in the embodiment operating in the discharge mode;

FIG. 7 is a chart for explaining how defects are detected in the embodiment operating in the float charge mode;

FIG. 8 is a chart for explaining how an abnormal voltage is detected in the battery unit in the embodiment;

FIG. 9 is a diagram showing a storage battery related to the embodiment and a connecting device used in the embodiment;

FIG. 10 is a view showing a washer used in the embodiment; and

FIG. 11 is a sectional view of the female tab used in the embodiment.

[0010] An embodiment of the present invention will be described, with reference to the accompanying drawings.

[0011] As shown in FIG. 1, a rectifier 2 is connected to a commercial AC power supply 1. An inverter 3 is connected to the output terminals P and N of the rectifier 2 by DC power supply lines L1 and L2.

The inverter 3 is switched, converting the output voltage of the rectifier 2 (a DC voltage) to an AC voltage having a predetermined frequency. The output of the inverter 3 is supplied to a load 4.

[0012] A battery unit 10 is connected between the DC power supply lines L1 and L2. The battery unit 10 comprises a plurality of storage batteries Sa, Sb, ... Sn, which are connected in series. Each storage battery is a sealed-type lead storage battery.

[0013] The battery unit 10 can be operated in various

modes, which are float charge mode, discharge mode and recharge mode.

[0014] In the float charge mode, the voltage of the power supply (rectifier 2) is applied to the load (inverter 3) connected to the battery unit 10, and the battery unit 10 is recharged by virtue of the voltage of the power supply (rectifier 2). 5

[0015] In the discharge mode, the voltage of the battery unit 10 is applied to the load (inverter 3) when the voltage of the power supply (rectifier 2) falls or is zero (when the supply of power is interrupted). 10

[0016] In the recharge mode, the battery unit 10 is recharged by virtue of the voltage of the power supply (rectifier 2), after the battery unit has operated in the discharge mode. 15

[0017] The rectifier 2, inverter 3 and battery unit 10 constitute an uninterruptible power supply system that keeps driving a load even if the commercially AC power supply 1 is interrupted.

[0018] In this uninterruptible power supply system, voltage detecting sections (first voltage detecting means) 11a, 11b, ... 11n are connected to the storage batteries Sa, Sb, ... Sn of the battery unit 10, respectively, to detecting the voltages V of the storage batteries Sa, Sb, ... Sn. Further, a temperature detecting section 12 is provided for the battery unit 10. The temperature detecting section 12 has a temperature sensor 12a attached to the battery unit 10. The temperature sensor 12a detects the temperature T of the battery unit 10 (or the ambient temperature of the battery unit 10). 20 25 30

[0019] A total voltage detecting section (second voltage detecting means) 13 is connected between the DC power supply lines L1 and L2, to detect the total voltage E of the battery unit 10.

[0020] A measuring section 21, a parameter setting section 22, a display section 23, and an alarm generating section 24 are connected to a control section 20. 35

[0021] The measuring section 21 performs A/D (analog-to-digital) conversion on the voltages V detected by the voltage detecting sections 11a, 11b, ... 11n, the temperature T detected by the temperature detecting section 12, and the voltage E detected by the total voltage detecting section 13, thereby generating digital data. The digital data is supplied to the control section 20. 40

[0022] The parameter setting section 22 is designed to set various parameters for operating the control section 20. 45

[0023] The display section 23 displays (informing) the results of operation of the control section 20.

[0024] The alarm generating section 24 generates an alarm signal when the control section 20 detects a defect in any one of the storage batteries, detects an abnormal voltage in the battery unit 10, or determines that the death of any one of the storage batteries (namely, the death of the battery unit 10). The alarm signal is transmitted (or given) to a central control room where inspection-maintenance workers are stationed. 50 55

[0025] The control section 20 has the following functional means [1] to [8]:

tional means [1] to [8]:

[1] Operation mode determining means for determining in which mode the battery unit 10 is operating, float charge mode, discharge mode, or recharge mode.

[2] First defect detecting means for detecting defects in the storage batteries Sa, Sb, ... Sn in accordance with whether the voltages V detected by the voltage detecting sections 11a, 11b, ... 11n are lower than a predetermined low voltage  $V_2$ , if the operation mode determining means determines that the battery unit 10 is operating in the float charge mode.

[3] Second defect detecting means for detecting defects in the storage batteries Sa, Sb, ... Sn in accordance with whether the voltages V detected by the voltage detecting sections 11a, 11b, ... 11n are equal to or higher than a predetermined high voltage  $V_3$ , if the operation mode determining means determines that the battery unit 10 is operating in the float charge mode.

[4] Third defect detecting means for detecting defects in the storage batteries Sa, Sb, ... Sn in accordance with whether the voltages V detected by the voltage detecting sections 11a, 11b, ... 11n are lower than a predetermined low voltage  $V_1$  ( $< V_2$ ) upon lapse of a prescribed time (e.g., one minute) from the start of the discharge mode, if the operation mode determining means determines that the battery unit 10 is operating in the discharge mode.

[5] First abnormality detecting means for detecting an abnormal voltage in the battery unit 10 in accordance with whether the voltage E detected by the total voltage detecting section 13 remains equal to or higher than a predetermined maximum value  $E_{max}$  for a prescribed time (alarm masking time) ta.

[6] Second abnormality detecting means for detecting an abnormal voltage in the battery unit 10 in accordance with whether the voltage E detected by the total voltage detecting section 13 remains lower than a predetermined minimum value  $E_{min}$  for a prescribed time (alarm masking time) tb.

[7] Life determining means for calculating an average of temperatures T detected by the temperature detecting section 12 at regular intervals (e.g., every hour), and for determining the life of the storage batteries Sa, Sb, ... Sn (namely, the life of the battery unit 10) on the basis of the relation between the average temperature and Arrhenius' rule.

[8] Information means for informing the defects detected by the various defect detecting means, the abnormalities detected by the various abnormality detecting means, and the life determined by the life detecting means.

[0026] The operation of the structure described above

will be described, with reference to the flow chart of FIGS. 2 and 3.

**[0027]** At first, time counts  $t_1$ ,  $t_2$ ,  $t_3$  and  $t_4$  are cleared (Step 101).

**[0028]** Upon lapse of a predetermined time, e.g., one hour, the temperature of the battery unit 10 is detected (if YES in Step 100). At the timing of detecting the temperature, the average (temperature of the battery unit 10) of the temperatures  $T$  that the temperature detecting section 12 has detected is calculated. On the basis of the relation between the average temperature and Arrhenius' rule, the life of the storage batteries  $S_a$ ,  $S_b$ , ...  $S_n$  (namely, the life of the battery unit 10) are determined (Step 102). If any storage battery is found to have dead (if YES in Step 103), the display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 104).

**[0029]** The voltage  $E$  detected by the total voltage detecting section 13 may become equal to or higher than the predetermined maximum value  $E_{max}$  (if YES in Step 105), as in Case A illustrated in FIG. 8. In this case, the time count  $t_1$  is started (Step 106). When the time count  $t_1$  reaches the prescribed value  $t_a$  (if YES in Step 107), it is determined that the total voltage  $E$  is abnormal (Step 108). The display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 109).

**[0030]** The voltage  $E$  detected by the total voltage detecting section 13 may fall below predetermined minimum value  $E_{min}$  (if YES in Step 110), as in Case B illustrated in FIG. 8. If this happens, the time count  $t_2$  is started (Step 111). When the time count  $t_2$  reaches the prescribed value  $t_b$  (if YES in Step 112), it is determined that the total voltage  $E$  is abnormal (Step 108). The display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 109).

**[0031]** The voltage  $E$  detected by the total voltage detecting section 13 (i.e., the total voltage) is compared with values  $E_1$  and  $E_2$  ( $E_1 < E_2$ ), the value  $E_1$  preset for detecting discharge and the value  $E_2$  preset for detecting the end of discharge (Step 113).

**[0032]** If the voltage  $E$  detected is equal to or higher than the preset value  $E_2$  (if YES in Step 113), it is determined that the battery unit 10 is operating in the float charge mode (Step 114). In this case, the low voltage  $V_2$  and the high voltage  $V_3$  are selected, both preset as reference values for detecting defects in the storage batteries (Step 115).

**[0033]** The voltage  $V$  detected by any one of the voltage detecting sections 11a, 11b, ... 11n may fall below the low voltage  $V_2$  as shown in FIG. 5, while the battery unit 10 is operating in the float charge mode. If so (if YES in Step 116), it is determined that the storage battery causing this voltage drop is defective (Step 118). The display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 119).

**[0034]** The voltage  $V$  detected by any one of the volt-

age detecting sections 11a, 11b, ... 11n may rise to or above the high voltage  $V_3$  as shown in FIG. 7, while the battery unit 10 is operating in the float charge mode. If this happens (if NO in Step 116 and YES in Step 117), it is determined that the storage battery causing this voltage rise is defective (Step 118). The display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 119).

**[0035]** The voltage  $E$  detected may fall below the preset value  $E_2$  (NO in Step 113) and may be lower than the preset value  $E_1$  (Step 120). If so, it is determined that the battery unit 10 is operating in the discharge mode (Step 121). In this case, the low voltage value  $V_1$  ( $< V_2$ ) is selected as reference for detecting a defect in each of the storage batteries (Step 122).

**[0036]** In the discharge mode, the time count  $t_3$  is started at the same time it is determined that the battery unit 10 is operating in the discharge mode (Step 123). When the time count  $t_3$  reaches one minute (i.e., the detecting masking time) (YES in Step 124), the voltages  $V$  detected by the voltage detecting sections 11a, 11b, ... 11n are compared with the low voltage value  $V_1$  ( $< V_2$ ) selected (Step 125).

**[0037]** If any one of the voltages  $V$  detected is lower than the preset low voltage value  $V_1$  as shown in FIG. 6 (if YES in Step 125), it is determined that the storage battery causing this voltage drop is defective (Step 118). The display section 23 displays this event and the alarm generating section 24 generates an alarm signal (Step 119).

**[0038]** If the detected voltage  $E$  rises to or above the preset value  $E_1$  (if NO in Step 120) and if the discharge mode is no longer valid (if YES in Step 126), it is determined that the battery unit 10 is operating in the recharge mode (Step 127). At the same time it is determined so, the time count  $t_4$  is started (Step 128). Until the time count  $t_4$  reaches 48 hours (if NO in Step 129), it is determined that recharge mode remains valid, regardless of changes in the detected voltage  $E$  (Step 127). Thus, for 48 hours corresponding to the time count  $t_4$ , it is not determined whether or not a defect exists in each storage battery (detection masking).

**[0039]** As informed above, an abnormal voltage of the battery unit 10 and defects in the storage batteries  $S_a$ ,  $S_b$ , ...  $S_n$  can be reliably detected without requiring the service of inspection-maintenance workers. In addition, the life of each storage battery can be determined and informed without requiring the service of inspection-maintenance workers.

**[0040]** The battery unit 10 and the storage batteries  $S_a$ ,  $S_b$ , ...  $S_n$  can be automatically managed with high reliability.

**[0041]** The voltage detecting sections 11a, 11b, ... 11n are connected to the battery unit 10 and storage batteries  $S_a$ ,  $S_b$ , ...  $S_n$  by means of the connecting device shown in FIGS. 9, 10 and 11. These figures illustrate only the connection of the storage battery  $S_a$  and the voltage detecting section 11a. Any other voltage detect-

ing section is connected to the associated storage battery in the same manner.

[0042] The storage battery Sa has a pair of bolt-shaped electrodes 41, which protrude from the upper surface of the sealed jar 40.

[0043] An electrically conductive washer 30 is secured to each of the electrodes 41. A connecting member 50, known as "female tab," is attached to the washer 30. A wire 58 is led from the female tab 50 and is connected to the voltage detecting section 11a.

[0044] A nut 42 is mounted on each electrode 41 of the storage battery Sa. The washer 30 and a connecting member 60 are attached to each electrode 41 in the order mentioned, and the nut 42 is fastened, gripping the electrode 41. The wire 61 led from each connecting member 60 is connected to one electrode 41 of the next storage battery Sb.

[0045] As shown in FIG. 10, the washer 30 has a ring-shaped part 32 and a flat connecting strip 33. The strip 33 outwardly protrudes from the ring-shaped part 32 in the radial direction and can be attached to and removed from the electrode 41. The electrode 41 can pass through the hole 31 of the ring-shaped part 32. The connecting strip 33 has such shape and size that it can be sufficiently inserted in the female tab 50 even when the nut 42 is fastened, gripping the electrode 41.

[0046] The female tab 50 comprises a housing 51 made of insulating material, a recess 52 made in one end of the housing 51, a pair of electrically conductive holding members 53 provided in the recess 52, a conductor 54 provided in the recess 52 and electrically connected to the holding members 53, a part-accommodating hole 55 extending from the bottom of the recess 52 to the proximal end 58a of a wire 58, and a series circuit composed of a fuse 56 and a resistor 57 which are provided in the part-accommodating hole 55.

[0047] One end 56a of the fuse 56 is connected to the conductor 54. The other end of the fuse 56 is connected by the resistor 57 to the proximal end 58a of the wire 58.

[0048] The resistor 57 functions as a protection resistor for preventing short-circuiting, if any in the load (i.e., wire 58 or voltage detecting section 11a), from changing the voltage of the storage battery Sa. The fuse 56 melts to prevent an excessively large current from flowing through the female tab 50 if short-circuiting or the like occurs in the load (i.e., wire 58 or voltage detecting section 11a).

[0049] The recess 52 is formed so large that the connecting strip 33 can be fully inserted into it. Each holding member 53 has been formed by bending a thin metal plate having electrical conductivity.

The holding members 53 work like leaf springs, reliably contacting and clamping the connecting strip 33 inserted in the recess 52. Due to the clamping, the washer 30 and the wire 58 are electrically connected to each other by the holding members 53, conductor 54, fuse 56 and resistor 57. Each holding member 53 is inclined or curved in the open end of the recess 52, so

that the connecting strip 33 may be smoothly inserted into the recess 52.

[0050] As described above, a washer 30 is fastened on each electrode 41 of the storage battery Sa, and a female tab 50 is attached to the connecting strip 33 of the washer 30. The storage battery Sa and the voltage detecting section 11a can thereby be connected easily and reliably. That is, the voltage detecting section 11a can be easily connected to the storage battery Sa, without removing the nut 42 or the connecting member 60 from the electrode 41 and without suspending the operation of the uninterruptible power supply system. Further, the efficiency of connecting the section 11a to the battery Sa is enhanced.

[0051] Since each holding member 53 of the female tab 50 reliably contacts the connecting strip 33 of the washer 30, stable and good electrical connection is maintained between the storage battery Sa and the voltage detecting section 11a.

[0052] If short-circuiting happens in the wire 58 or the voltage detecting section 11a, unnecessary voltage changes can be prevented in the storage battery Sa. This is because each female tab 50 has a resistor 57.

[0053] An excessively large current may flow through each female tab 50 due to short-circuiting in the wire 58 or the voltage detecting section 11a. In this case, the fuse of the female tab 50 melts, thereby preventing a fire or the like.

[0054] In the embodiment described above, each holding member 53 has been formed by bending a metal plate. Nonetheless, there is no limitation to the shape and the like of each holding member 53. The member 53 may have any shape, provided that it can reliably contact the connecting strip 33. For example, one of the holding members 53 may be formed by bending a metal plate, and the other holding member 53 may be an insulating member made of rubber or the like.

[0055] There are no limitations to the shape of the washer 30, either.

[0056] The apparatus described above is designed for use in an uninterruptible power supply system. Nevertheless, the apparatus can be used in any other system that has storage batteries.

[0057] The present invention is not limited to the embodiment described above. Various changes and modifications can be made within the scope and spirit of the invention.

#### Claims

1. An apparatus for managing a battery unit having a plurality of storage batteries, characterized by comprising:

a plurality of first voltage detecting means (11a, 11b, ... 11n) for detecting voltages of the storage batteries (Sa, Sb, ... Sn), respectively;  
second voltage detecting means (13) for



- detecting a total voltage of the battery unit (10);  
 defect detecting means (20) for detecting defects in the storage batteries (Sa, Sb, ... Sn) on the basis of the voltages detected by the first voltage detecting means (11a, 11b, ... 11n);  
 abnormality detecting means (20) for detecting an abnormal voltage in the battery unit (10) on the basis of the voltage detected by the second voltage detecting means;  
 temperature detecting means (12) for detecting temperature in the battery unit (10);  
 battery life determining means (20) for determining a life of each of the storage batteries (Sa, Sb, ... Sn) has dead, on the basis of the temperature detected by the temperature detecting means (12); and  
 information means (23) for informing results of the detection performed by the defect detecting means (20) and abnormality detecting means (20) and results of the determination made by the battery life determining means (20).
2. An apparatus according to claim 1, characterized in that the storage batteries (Sa, Sb, ... Sn) are sealed-type lead storage batteries and are connected in series.
  3. An apparatus according to claim 1, characterized by further comprising operating mode determining means (20) for determining an operation mode of the battery unit (10).
  4. An apparatus according to claim 3, characterized in that the defect detecting means (20) detects defects in the storage batteries (Sa, Sb, ... Sn) by comparing the voltages detected by the first voltage detecting means (11a, 11b, ... 11n) with a level set on the basis of the operation mode determined by the operating mode determining means (20).
  5. An apparatus according to claim 3, characterized in that the abnormality detecting means (20) detects an abnormal voltage in the battery unit (10) by comparing the voltage detected by the second voltage-detecting means (13) with a predetermined upper-limit value and by comparing the voltage detected by the second voltage-detecting means (13) with a predetermined lower-limit value.
  6. An apparatus according to claim 3, characterized in that the operating mode determining means (20) determines in which operation mode the battery unit (10) is operating, float charge mode, discharge mode, or recharge mode, on the basis of the voltage detected by the second voltage detecting means (13); in said float charge mode, the voltage of a power supply (2) connected to the battery unit (10) is applied to a load (3) connected to the battery unit (10), and the battery unit (10) is charged by virtue of the voltage of the power supply (2); in said discharge mode, the voltage of the battery unit (10) is applied to the load (3) when the voltage of the power supply (2) falls or is zero; and in said recharge mode, the battery unit (10) is recharged by virtue of the voltage of the power supply (2) after the battery unit (10) has operated in the discharge mode.
  7. An apparatus according to claim 6, characterized in that the defect detecting means (20) comprises first defect detecting means, second defect detecting means, and third defect detecting means; said first defect detecting means detects defects in the storage batteries (Sa, Sb, ... Sn) in accordance with whether the voltages detected by the first voltage detecting means (11a, 11b, ... 11n) are lower than a predetermined low voltage  $V_2$ , when the operation mode determined by the operation mode determining means is the float charge mode; said second defect detecting means detects defects in the storage batteries (Sa, Sb, ... Sn) in accordance with whether the voltages detected by the first voltage detecting means (11a, 11b, ... 11n) are equal to or higher than a predetermined high voltage  $V_3$ , when the operation mode determined by the operation mode determining means is the float charge mode; and the third defect detecting means for detecting defects in the storage batteries (Sa, Sb, ... Sn) in accordance with whether the voltages detected by the first voltage detecting means (11a, 11b, ... 11n) are lower than a predetermined low voltage  $V_1$  ( $< V_2$ ) upon lapse of a prescribed time from the start of the discharge mode, when the operation mode determined (20) by the operation mode determining means is the discharge mode.
  8. An apparatus according to claim 6, characterized in that the abnormality detecting means (20) comprises first abnormality detecting means and second abnormality detecting means; said first abnormality detecting means detects an abnormal voltage in the battery unit (10) in accordance with whether the voltage detected by the second voltage detecting means (13) remains equal to or higher than a predetermined maximum value for a prescribed time; and the second abnormality detecting means for detecting an abnormal voltage in the battery unit (10) in accordance with whether the voltage detected by the second voltage detecting means (13) remains lower than a predetermined minimum value for a prescribed time.
  9. An apparatus according to claim 1, characterized in that each of said storage batteries (Sa, Sb, ... Sn) has a pair of electrodes (41).

10. An apparatus according to claim 9, characterized by further comprising connecting devices, each for the connecting one electrodes (41) of one storage battery to one first voltage detecting means.

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11. An apparatus according to claim 10, characterized in that each of the connecting devices comprises a washer (30) to be removably attached to one electrode (41), a connecting member (50) to be removably connected to the washer (30), and a wire (58) extending from the connecting member (50).

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12. An apparatus according to claim 11, characterized in that the washer (30) has a ring-shaped part (32) and a connecting strip (33) extending outwardly from the ring-shaped part (32) in a radial direction thereof; the connecting member (50) has a recess (52) for receiving and holding the connecting strip (33) of the washer (30) and a series circuit provided between the recess (52) and the wire (58) and composed of a fuse (56) and a resistor (57); and series circuit connects the connecting strip (33) to the wire (58) when the connecting strip (33) is inserted into the recess (52).

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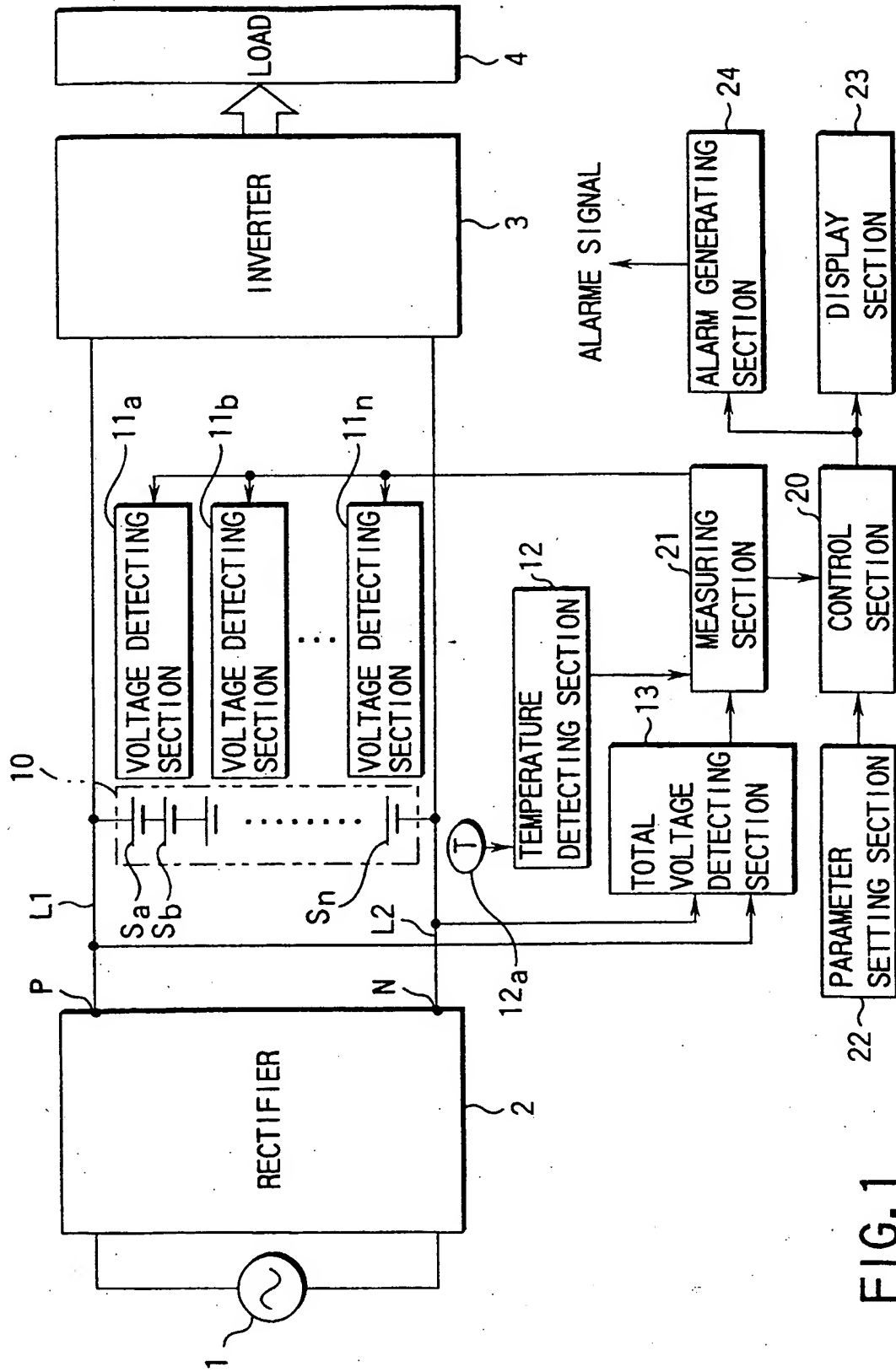


FIG. 1

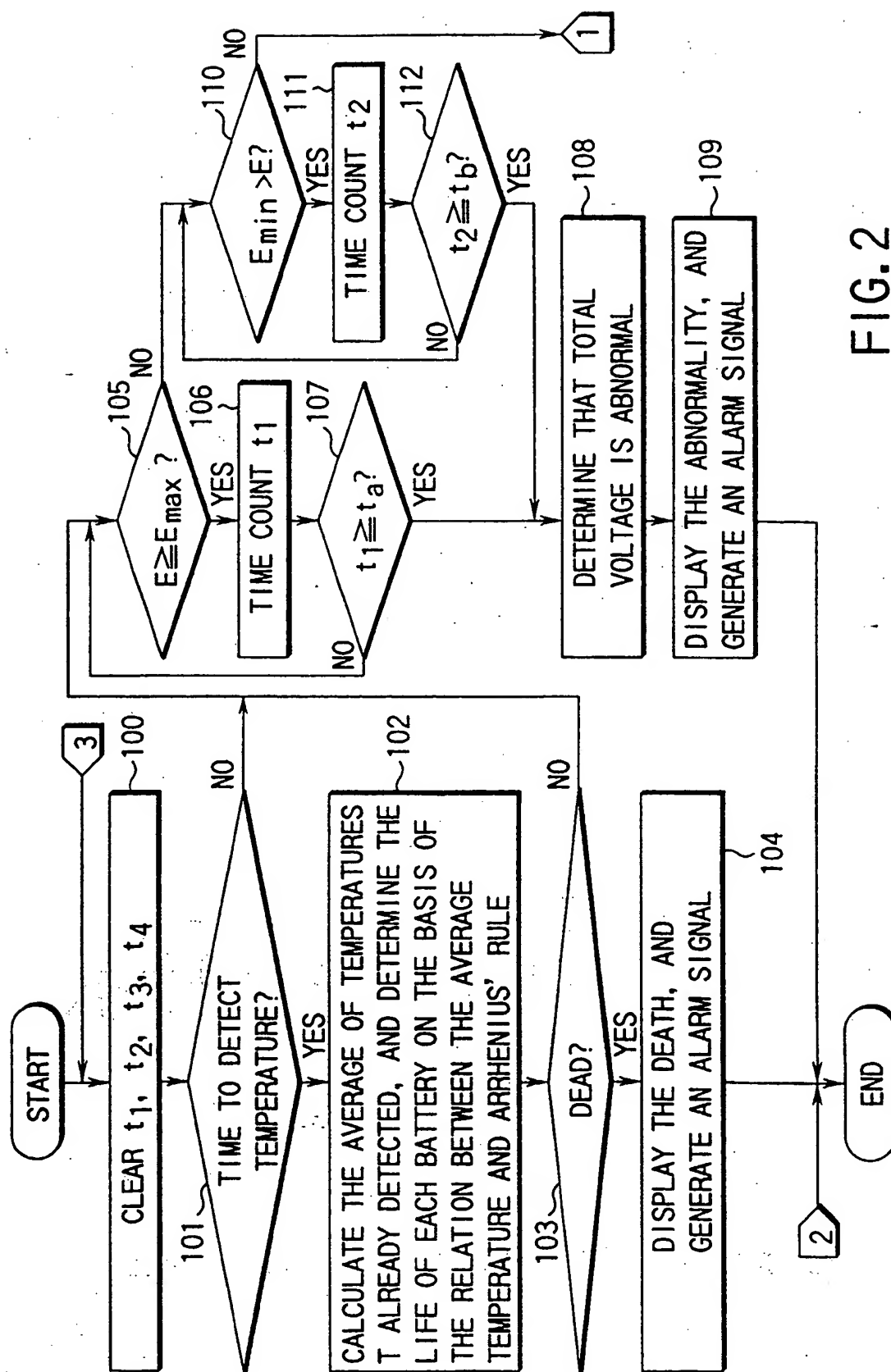


FIG. 2

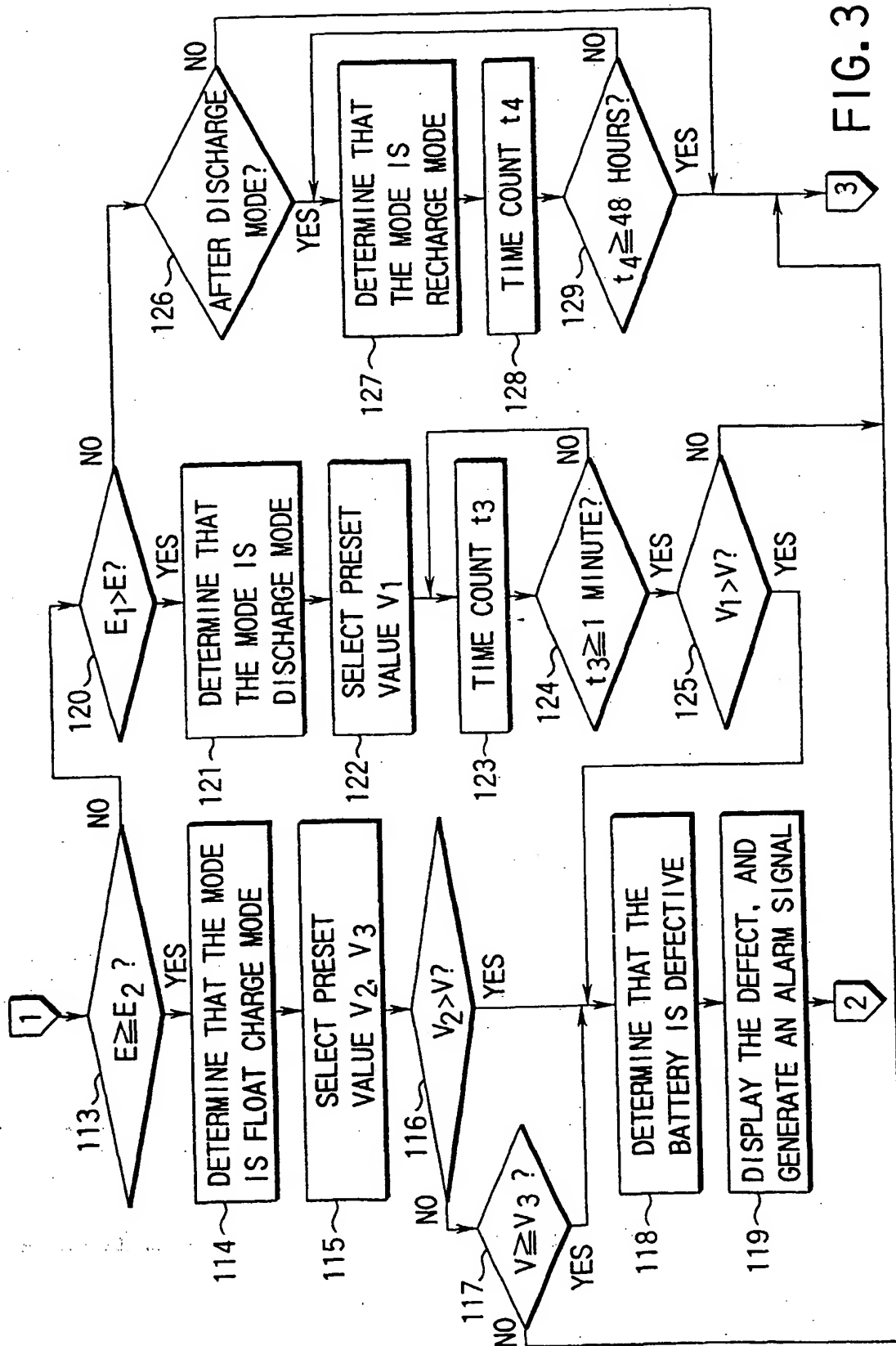
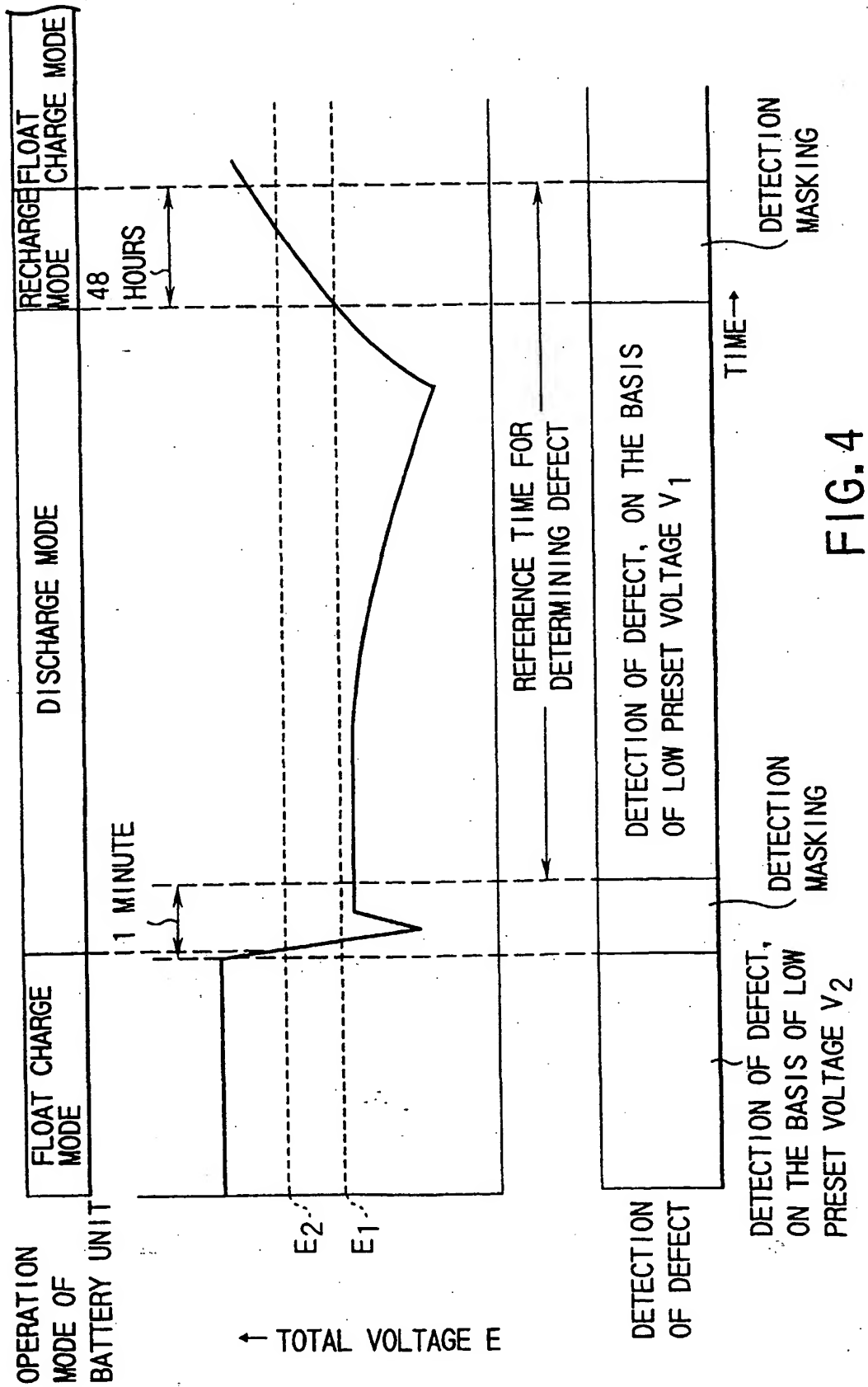


FIG. 3



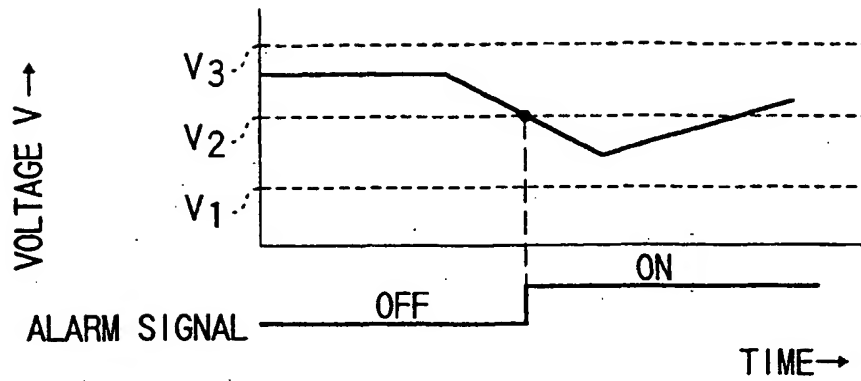


FIG. 5

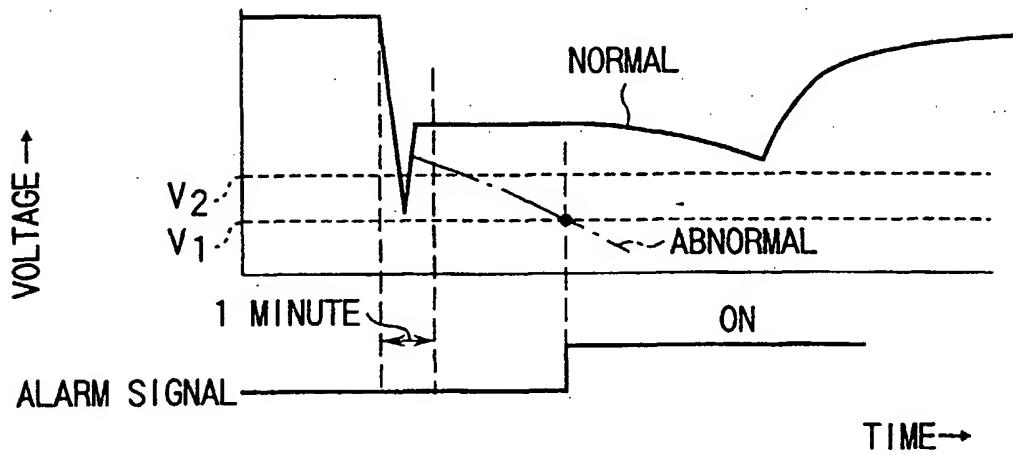


FIG. 6

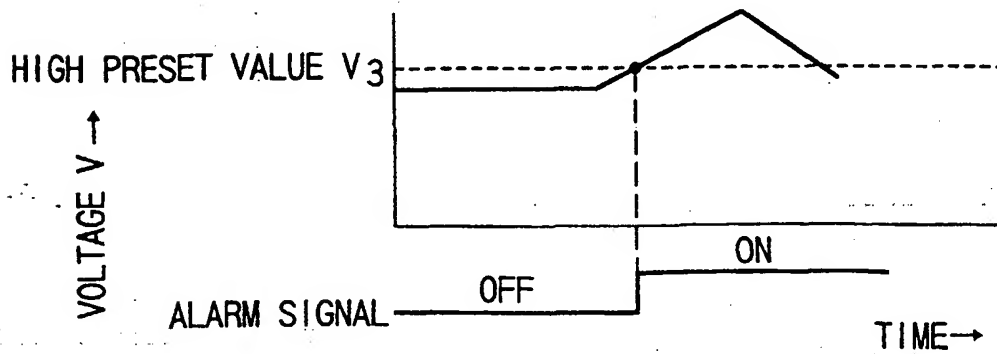


FIG. 7

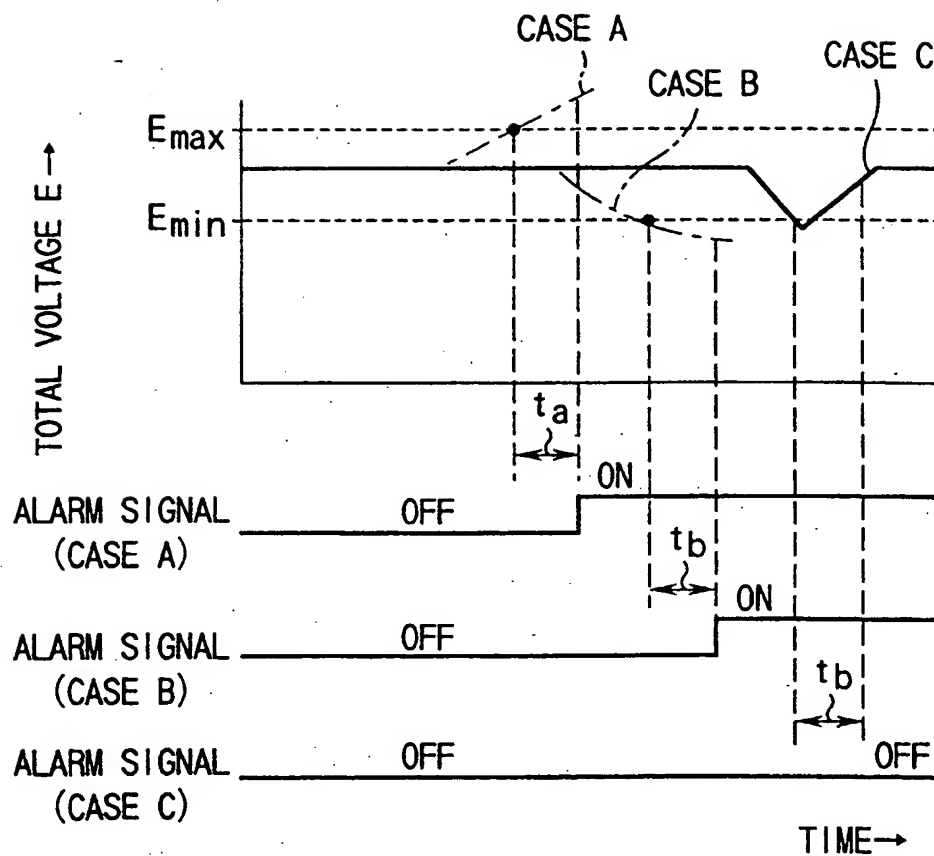


FIG. 8



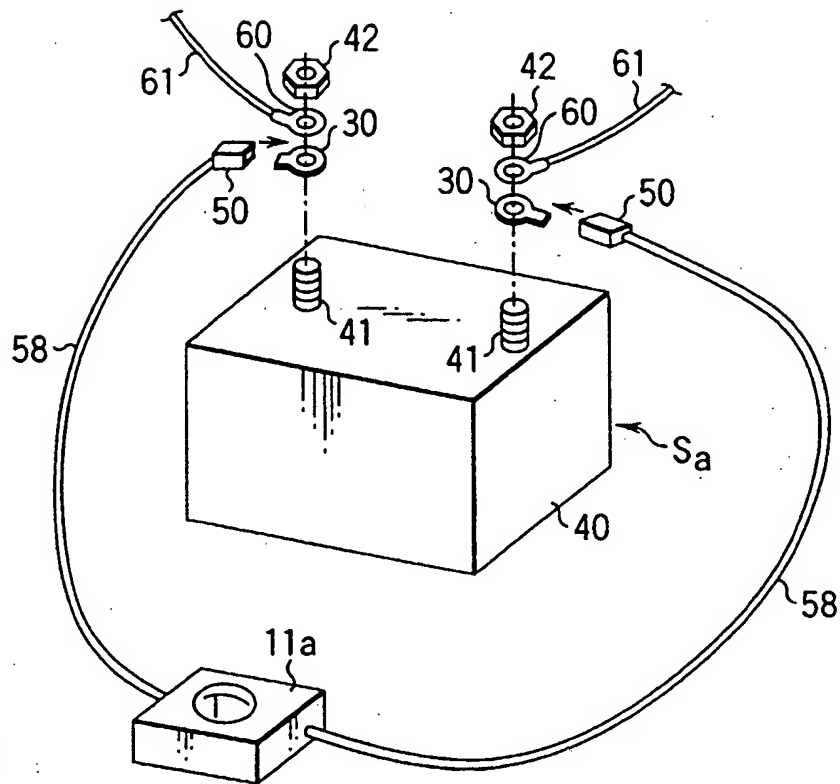


FIG. 9

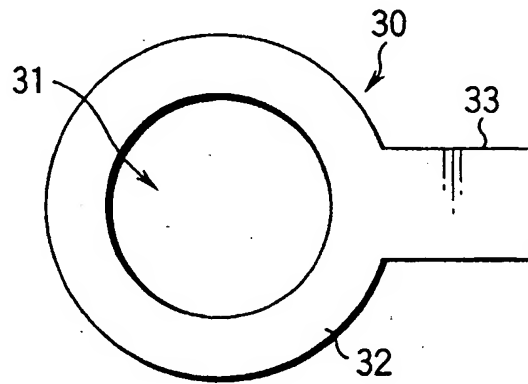


FIG. 10

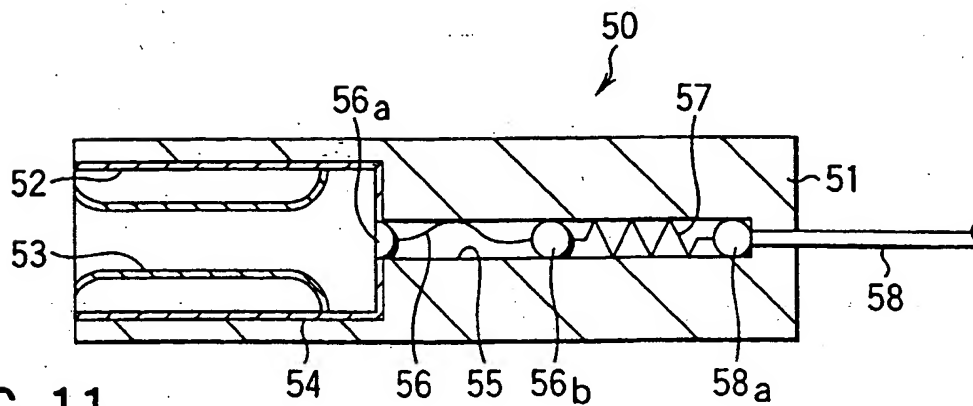


FIG. 11